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(54) **REFRIGERATION CIRCUIT**

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F25B 45/00 (2006.01)

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See application file for complete search history.

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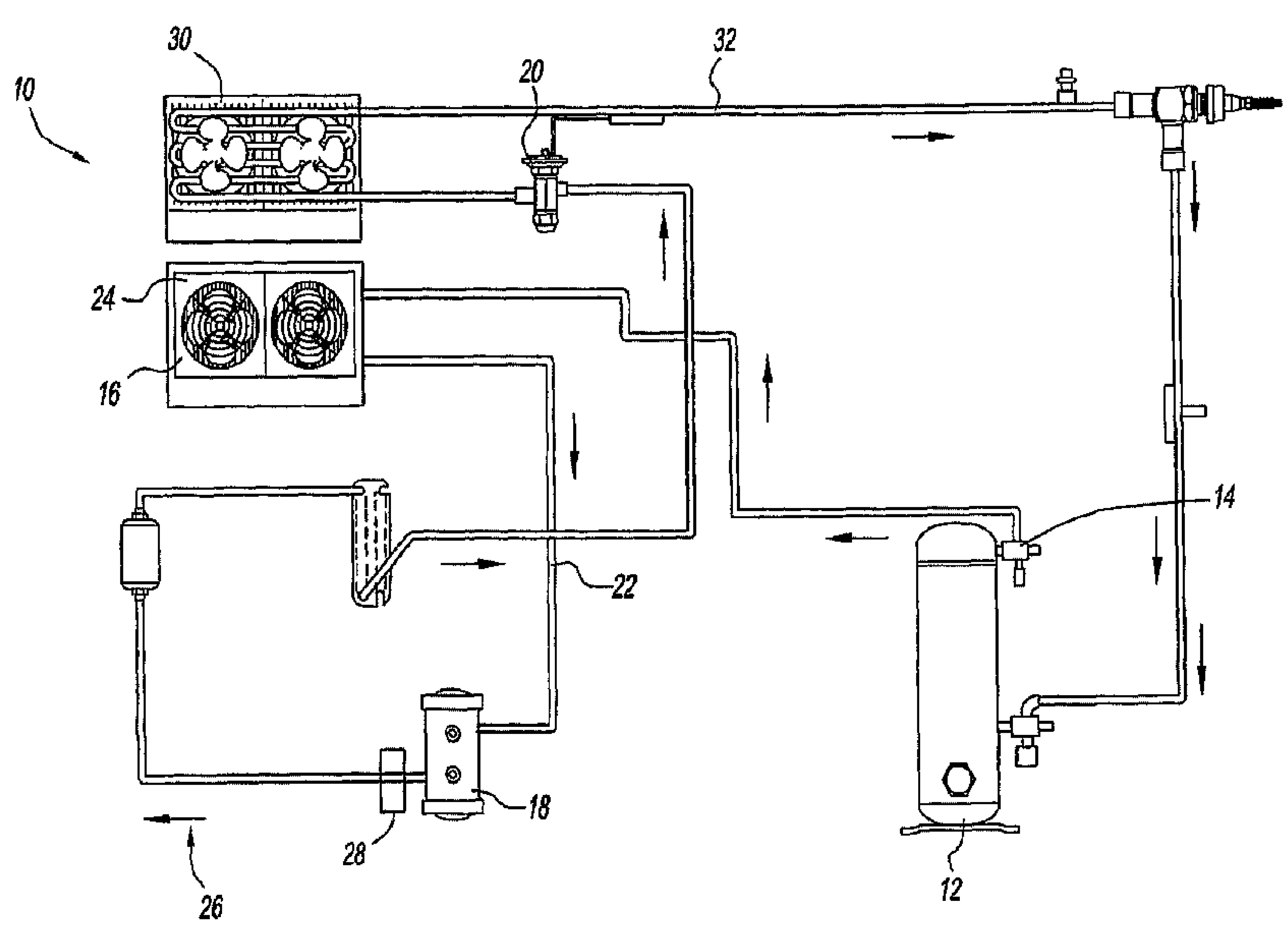
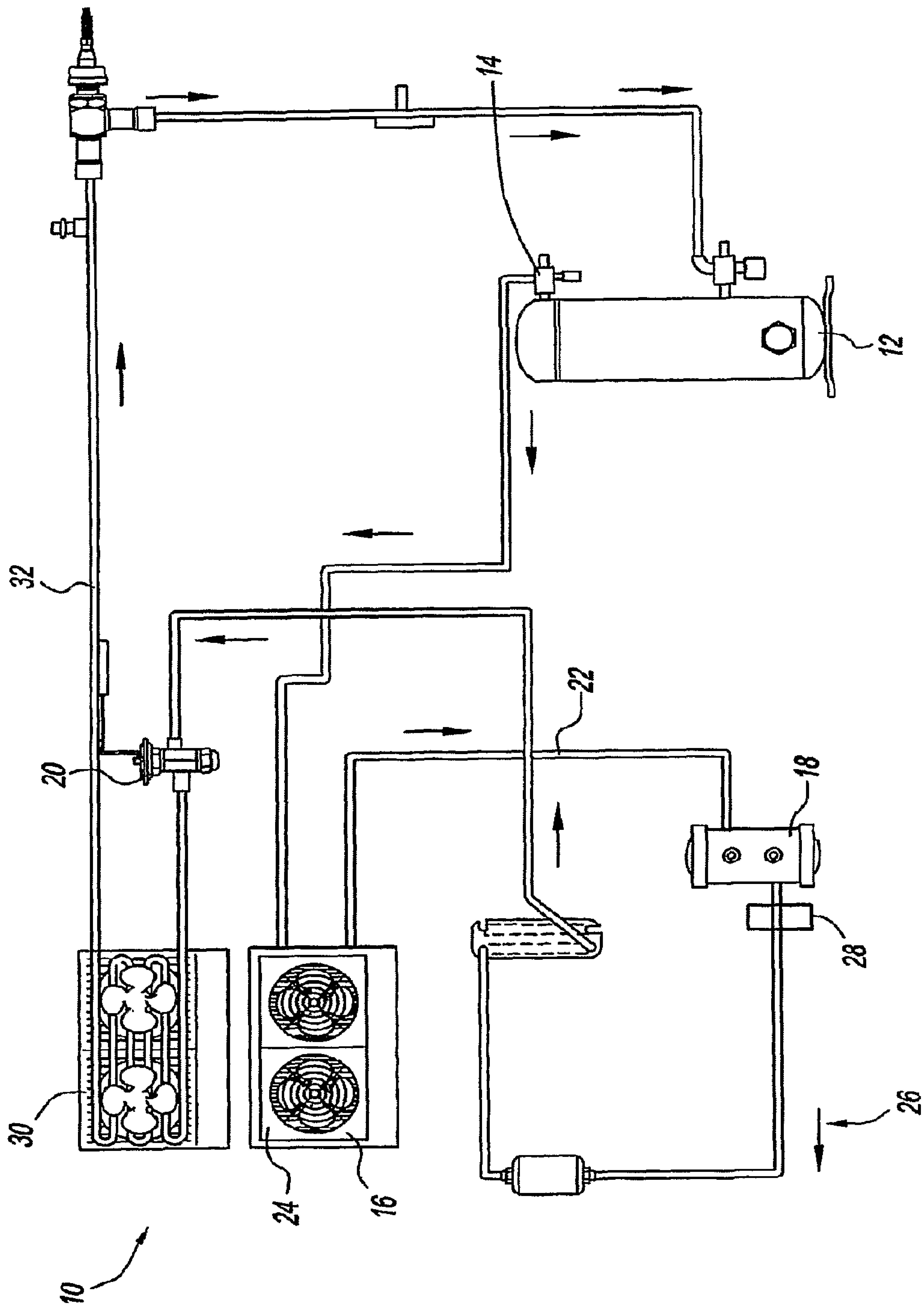
(57) **ABSTRACT**

A refrigeration circuit having a system charge and a system charge storage area. The system charge area has a condenser having a set of micro-channel heat exchanger coils. The condenser is appropriately sized to receive a first volume of the system charge. There is a compressor for compressing the system charge from an expanded state to a compressed state. There is a sealed refrigerant charge holding area fluidly connected to the condenser and the compressor. The sealed refrigerant charge holding area is appropriately sized for storing a second volume of the system charge during a system pumpdown. A receiver is fluidly connected to the sealed refrigerant charge holding area. The receiver is appropriately sized to receive a third volume of the system charge during a system pumpdown.

8 Claims, 1 Drawing Sheet

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REFRIGERATION CIRCUIT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present disclosure is related to a refrigeration circuit. More particularly, the present disclosure is related to a refrigeration circuit having a sealed refrigerant charge holding area.

2. Description of Related Art

Refrigeration circuits are typically used in a number of devices in order to cool the temperature of ambient air. A typical refrigeration circuit contains at least a compressor, a condenser, a receiver, a series of valves, at least one evaporator, and a system charge which circulates throughout.

Periodically, various components of the circuit need to be serviced, repaired, and/or replaced. In order to do so, the system charge must be removed from the components that will need servicing. One method that is currently used to prepare the circuit for servicing is to drain all of the system charge from the circuit. The system charge can not be re-used and must be disposed of. Due to various environmental regulations, costs associated with the proper disposal of the spent system charge can be great. Therefore, this method may be undesirable.

A second method commonly used to prepare a circuit for servicing involves a "system pumpdown". In a system pumpdown, the compressor compresses all of the system charge which is then stored in a designated area within the circuit. This is advantageous in that it avoids having to remove and dispose of the system charge thereby, avoiding disposal costs and costs associated with new system charge.

In order for a system pumpdown to be effective, the designated storage area must have sufficient volume in which to store the compressed charge. Problems arise, however, when modifications to the circuit are made within the designated area, that reduce the volume available for storage. For example, in some refrigeration circuits, the condenser is included in the designated storage area. Round tube and fin condenser ("RTF") coils are frequently used in condensers. RTF coils have large internal volumes and provide sufficient space so that the compressed system charge can be stored within the storage area. However, when micro-channel heat exchanger ("MCHX") coils are substituted for the RTF coils, there is a reduction in storage volume. The heat transfer coefficient is higher for MCHX type construction than for RTF, so whenever this type of replacement is made for coils of equal capacity the internal volume (storage area) will be reduced. Problems will, therefore, arise during a system pumpdown as there is not sufficient space to store the compressed system charge.

There exists a need for a refrigeration circuit that can compensate for modifications made within the designated area that reduce the volume available for storage during a system pumpdown. Specifically, there exists a need for a refrigeration circuit that can compensate for the reduction in storage volume within a designated area when micro-channel heat exchanger coils are substituted for pre-existing coils within the condenser. The present disclosure provides such a circuit.

BRIEF SUMMARY OF THE INVENTION

It is an object of the present invention to provide a refrigeration circuit having a sealed refrigerant charge holding area.

These and other objects and advantages of the present invention are provided by a refrigeration circuit having a system charge and a system charge storage area. The system charge area has a condenser having a set of micro-channel heat exchanger coils. The condenser is appropriately sized to reject heat loads from external sources, ambient air, and air side heat sources such as evaporator motors and the compressor motor if it is inside the refrigeration circuit. Additionally, the condenser is appropriately sized to receive a first volume of the system charge. There is a compressor for compressing the system charge from an expanded state to a compressed state. There is a sealed refrigerant charge holding area fluidly connected to the condenser and the compressor. The sealed refrigerant charge holding area is appropriately sized for storing a second volume of the system charge during a system pumpdown. A receiver is fluidly connected to the sealed refrigerant charge holding area. The receiver is appropriately sized to receive a third volume of the system charge during a system pumpdown.

The above-described and other features and advantages of the present invention will be appreciated and understood by those skilled in the art from the following detailed description, drawings, and appended claims.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The FIGURE is a schematic representation of an exemplary embodiment of a refrigeration circuit according to the present disclosure.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings and in particular to the FIGURE, a refrigeration circuit **10** is generally illustrated. Advantageously, refrigeration circuit **10** contains a sealed refrigerant charge holding area, situated between the condenser and the receiver, that can be used to store system charge during a system pump down.

Refrigeration circuit **10** contains a compressor **12**, a discharge service valve **14**, a condenser **16**, a receiver **18**, a thermostatic expansion valve **20**, a sealed refrigerant charge holding area **22**, an evaporator **30**, a high side service valve **28**, and a system charge **32**. Additionally, refrigeration circuit **10** has a direction of system charge flow **26**.

It is contemplated by the present disclosure that compressor **12** may be any known type that allows refrigeration circuit **10** to operate as contemplated herein. For example, in one embodiment, when refrigeration circuit **10** is used in a transport refrigeration system Scroll Compressor RS105 manufactured by Scroll Technologies may be used.

Discharge service valve **14** is fluidly connected to compressor **12** and is positioned upstream in the direction of system charge flow **26**. Discharge service valve **14** can be any known type suitable so that refrigeration circuit **10** can perform as contemplated herein. For example, in one embodiment, discharge service valve **14** may be selected from the group consisting of ball valves and compressor service valves.

Condenser **16** is situated upstream of discharge service valve **14** in direction of system charge flow **26**. It is contemplated herein that condenser **16** can be any known type sufficient such that the condenser is suitable for the functioning of refrigeration circuit **10**. For example, when refrigeration circuit **10** is used in a transport refrigeration system, a 7 millimeter round tube & fin condenser supplied by Carrier International Sdn Bhd (CISB) may be used. Additionally, condenser **16** contains a series of coils **24**. The system charge flows through series of coils **24** and is cooled by an airstream that passes over the coils. It is contemplated in the present disclosure that series of coils **24** may be any type suitable such as to allow performance of refrigeration circuit **10**. In one embodiment of the present disclosure, series of coils **24** are micro-channel heat exchanger coils.

Sealed refrigerant charge holding area **22** is fluidly connected to condensor **16** and receiver **18**. In a preferred embodiment, sealed refrigerant charge holding area **22** is a pipe. The pipe may be made of metal, plastic, plastic composite, and any combination thereof. Additionally, sealed refrigerant charge holding area **22** has a diameter in the range of ⅝ inches to two inches, preferably 1¼", and any subranges there between. Additionally, sealed refrigerant charge holding area **22** has a length in the range of 6 inches to 60 inches, preferably 36 inches, and is angled on a downward slope from condenser **16** to receiver **18**. In one embodiment, the downward slope has a minimum value of at least 2 degrees. If the minimum angle is not obtained, thermostatic expansion valve **20** can be starved of refrigerant. In another embodiment of the present disclosure, sealed refrigerant charge holding area **22** comprises at least one or more adapter pieces that mate sealed refrigerant charge holding area **22** to a pre-existing pipe-system.

Receiver **18** is fluidly connected to sealed refrigerant charge holding area **22**. It is contemplated herein that receiver **18** can be any known type having properties that allow refrigeration circuit **10** to be operable. For example, when refrigeration circuit **10** is used in a refrigeration transport system, a 3 inch diameter all Copper pressure vessel manufactured by Spinco Metal Products Inc. can be used. In one embodiment of the present disclosure, high side service valve **28** may be situated downstream of receiver **18**. High side service valve **28** may be any known valve suitable for use in refrigeration circuit **10**.

Thermostatic expansion valve **20** is situated upstream of receiver **18**. Thermostatic expansion valve **20** is any valve known in the art suitable for use in refrigeration circuit **10**. For example, thermostatic expansion valve **20** may be an externally equalized expansion valve manufactured by Danfoss Refrigeration and Air Conditioning.

System charge **32** is any known type suitable for operation of refrigeration circuit **10**. For example, in one embodiment of the present disclosure, system charge **32** is HFC-134a manufactured by Dupont.

During use, refrigeration circuit **10** operates in a known manner. For example, compressor **12** will receive a signal and begin compressing the system charge **32**. System charge **32** subsequently flows through set of coils **24** in condenser **16**. Condenser **16** contains a fan that blows an airstream over set of coils **24** thereby cooling system charge **32** that is flowing through the set of coils. System charge **32** then flows through receiver **18** and upstream in direction of charge flow **26** until it reaches thermostatic expansion valve **20**. When thermostatic expansion valve **20** is closed, the cooled, compressed system charge **32** will collect until such time as thermostatic expansion valve **20** is opened. When thermostatic expansion valve **20** is opened, compressed system charge **32** expands and flows through evaporator **30** wherein heat is exchanged. System charge **32** then flows through to compressor **12** where it collects. When a signal is received by compressor **12**, refrigeration circuit **10** starts again.

During a system pumpdown, high side service valve **28** is closed. A signal is then received by compressor **12** and the compressor is turned on. Compressor **12** then compresses essentially all of system charge **32**. In one embodiment, after system charge **32** has been compressed, discharge service valve **14** is closed and system charge **32**, in a compressed state, is contained between discharge service valve **14** and high side service valve **28**. Service can then be performed on evaporators **30**, thermostatic expansion valve **20**, compressor **12** and any circuit parts therebetween.

In one embodiment of the present disclosure, refrigeration circuit **10** has condenser **16** having set of coils **24** in which micro-channel heat exchanger coils have been substituted for pre-existing RTF coils. Because micro-channel heat exchanger coils have a smaller storage volume than RTF coils for storing compressed system charge **32** during a system pumpdown, sealed refrigerant charge holding area **22** has been designed with dimensions to account for the reduction in storage volume of set of coils **24**. By providing refrigerant charge holding area **22** having enlarged dimensions on 1¼"×36", the additional volume of compressed system charge **32** can be stored.

Increasing the dimensions of sealed refrigerant charge holding area **22** is counterintuitive to standard practices in the refrigeration industry. Currently, manufacturers of refrigeration circuits design the circuits so that receiver **18** is always filled with system charge **32**. There must always be system charge **32** in receiver **18** in order for the receiver to be operable. Thus, according to standard practices, refrigeration circuit **10** would be designed with a larger receiver with additional volume to store compressed system charge **32**.

This would be problematic, however, because of increased expenses associated with the use of a larger receiver. The receiver would not only be more expensive, but there would also be increased engineering and design expenses. Additionally, a receiver of sufficiently large size may need to be treated as an ASME pressure vessel. As such, the receiver would be subject to numerous regulations also resulting in an increase expenses.

Although counterintuitive to standard practices, increasing the size of sealed refrigerant charge holding area **22** in refrigeration circuit **10**, as contemplated in the present disclosure, allows for storage of compressed system charge **32** during system pumpdown. Additionally, by designing sealed refrigerant charge holding area **22** with a downward slope to receiver **18**, this ensures that the receiver will always have system charge thereby rendering the refrigeration circuit operable.

It should also be noted that the terms “first”, “second”, “third”, “upper”, “lower”, and the like may be used herein to modify various elements. These modifiers do not imply a spatial, sequential, or hierarchical order to the modified elements unless specifically stated.

While the present disclosure has been described with reference to one or more exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the present disclosure. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the disclosure without departing from the scope thereof. Therefore, it is intended that the present disclosure not be limited to the particular embodiment(s) disclosed as the best mode contemplated, but that the disclosure will include all embodiments falling within the scope of the appended claims.

What is claimed is:

1. A refrigeration circuit having a system charge and a system charge storage area, said system charge area comprising:

a condenser having a set of micro-channel heat exchanger coils, said condenser appropriately sized to receive a first volume of the system charge;

a compressor for compressing the system charge from an expanded state to a compressed state;

a sealed refrigerant charge holding area fluidly connected to said condenser and said compressor, said sealed refrigerant charge holding area appropriately sized for storing a second volume of the system charge during a system pumpdown; and

a receiver fluidly connected to said sealed refrigerant charge holding area, said receiver appropriately sized to receive a third volume of the system charge during a system pumpdown;

wherein the sealed refrigerant charge holding area is positioned on a downward slope from the condenser to the receiver.

2. The refrigeration circuit of claim **1**, wherein said sealed refrigerant charge holding area is a pipe.

3. The refrigeration circuit of claim **2**, wherein said pipe is selected from the group consisting of metal, plastic, plastic composite, and any combination thereof.

4. A refrigeration circuit having a system charge and a system charge storage area, said system charge area comprising:

a condenser having a set of micro-channel heat exchanger coils, said condenser appropriately sized to receive a first volume of the system charge;

a compressor for compressing the system charge from an expanded state to a compressed state;

a sealed refrigerant charge holding area fluidly connected to said condenser and said compressor, said sealed refrigerant charge holding appropriately sized for storing a second volume of the system charge during a system pumpdown; and

a receiver fluidly connected to said sealed refrigerant charge holding area, said receiver appropriately sized to receive a third volume of the system charge during a system pumpdown;

wherein said sealed refrigerant charge holding area has a diameter of between ⅝ inch and 2 inches.

5. A refrigeration circuit having a system charge and a system charge storage area, said system charge area comprising:

a condenser having a set of micro-channel heat exchanger coils, said condenser appropriately sized to receive a first volume of the system charge;

a compressor for compressing the system charge from an expanded state to a compressed state;

a sealed refrigerant charge holding area fluidly connected to said condenser and said compressor, said sealed refrigerant charge holding area appropriately sized for storing a second volume of the system charge during a system pumpdown; and

a receiver fluidly connected to said sealed refrigerant charge holding area, said receiver appropriately sized to receive a third volume of the system charge during a system pumpdown;

wherein said sealed refrigerant charge holding area has a length in the range of 6 inches to 60 inches.

6. A refrigeration circuit having a system charge and a system charge storage area, said system charge area comprising:

a condenser having a set of micro-channel heat exchanger coils said condenser appropriately sized to receive a first volume of the system charge;

a compressor for compressing the system charge from an expanded state to a compressed state;

a sealed refrigerant charge holding area fluidly connected to said condenser and said compressor, said sealed refrigerant charge holding area appropriately sized for storing a second volume of the system charge during a system pumpdown;

a receiver fluidly connected to said sealed refrigerant charge holding area, said receiver appropriately sized to receive a third volume of the system charge during a system pumpdown; and

an evaporator fluidly connected to said condenser, wherein a heat transfer between the system charge and ambient air occurs.

7. The refrigeration circuit of claim **6**, further comprising a thermostatic expansion valve fluidly connected to said evaporator, said thermostatic expansion valve regulating the flow of the system charge throughout the refrigeration circuit.

8. A refrigeration circuit having a system charge and a system charge storage area, said system charge area comprising:

a condenser having a set of micro-channel heat exchanger coils, said condenser appropriately sized to receive a first volume of the system charge;

a compressor for compressing the system charge from an expanded state to a compressed state;

a sealed refrigerant charge holding area fluidly connected to said condenser and said compressor, said sealed refrigerant charge holding area appropriately sized for storing a second volume of the system charge during a system pumpdown;

a receiver fluidly connected to said sealed refrigerant charge holding area, said receiver appropriately sized to receive a third volume of the system charge during a system pumpdown; and

a high side service valve located upstream and fluidly connected to said receiver, said high side service valve for regulating the flow of the system charge throughout the refrigeration circuit.

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